accepted a professorship of physical chemistry at Purdue University.

DR. L. D. BRISTOL, now of Syracuse Medical School, has been appointed to succeed Dr. G. F. Ruediger as director of the public health laboratory of the University of North Dakota. Dr. R. T. Young has been appointed professor of zoology and succeeds Dean M. A. Brannon as director of the University Biological station at Devil's Lake.

DR. PRAFULLA CHANDRA RÂY has been appointed to the Sir Taraknath Palit professorship of chemistry, and Mr. C. V. Raman to the Sir Taraknath Palit professorship of physics in the Presidency College, Calcutta.

## *DISCUSSION AND CORRESPONDENCE*

### DADOURIAN'S ANALYTICAL MECHANICS AND THE PRINCIPLES OF DYNAMICS

PROFESSOR E. W. RETTGER'S review of my "Analytical Mechanics," which appeared in number 995 issue of SCIENCE, gives a wrong impression of my treatment of the principles of dynamics.

The reviewer's criticisms are directed, mainly, against my claim of having based the science of mechanics upon a single dynamical principle. Starting from certain premises, which can not stand close examination, Professor Rettger arrives at the conclusion

> He makes more assumptions than are usually made in elementary text-books of mechanics.

Let us consider the main points of his criticisms in detail and see whether the foregoing statement is based upon facts.

> On page 16, he introduces the conception of ''force'' as an ''action'' and without hesitation applies vector addition to a system of forces. What is he doing here, but assuming the ''parallelogram of forces'' in its most general form?

It is intimated here that the "parallelogram of forces" is a dynamical law which I have "assumed" without formally introducing it as a new law. It is a fact that I have applied vector addition to forces "without hesitation," but I have shown as little hesitation in treating velocities, accelerations, torques, linear momenta and angular momenta as vectors. Why did not Professor Rettger accuse me of having assumed the "parallelograms" of these magnitudes? Is the "parallelogram of forces" more of a dynamical law than the "parallelogram" of torques, for instance? The "parallelogram" law applies to any vector and is not at all a characteristic of forces, therefore it is not a dynamical law. It does not even deserve being called a "law" when applied to a special type of vectors. In its most general form the "parallelogram law" is the principle of the independence of mutually perpendicular directions in space, a purely geometrical principle. A special case of it is known to students of plane trigonometry as the "law of cosines." In the first chapter of my book this principle is given in its most general form as well as in its several special forms, and is applied to vector magnitudes of different types. After devoting an entire chapter to vector addition and after defining force as a vector, to introduce the "paralellogram of forces" as a new law, as Professor Rettger would have it, could serve only to show that the man who did it could not have a clear conception of the meanings of the terms he was using.

> On page 102 he assumes that a force is proportional to the acceleration produced. This assumes Newton's second law.

This statement is not quite right. The relation between force and acceleration, which I have called *force-equation,* is derived on page 106 from the fundamental principle which I have postulated. In this derivation I have made use of the definition of *kinetic reaction,* which is stated and illustrated on pages 102 to 105, but this is not equivalent to "assuming" a new principle. Will Professor Rettger claim that to define the terms used in a principle is equivalent to introducing or "assuming" new principles? Suppose I had based my work upon the principles of the conservation of energy and of the conservation of momentum should I have no right to classify and define the different forms of energy and of momentum without being rightly accused of having introduced new principles? Will Professor Rettger consider the definitions of momentum, of potential energy, and of kinetic

energy as principles and state that mechanics can not be based upon the principles of the conservation of energy and of momentum alone?

What about the law itself? The first part of the law is clear. "To every action there is an equal and opposite reaction" is nothing but Newton's third law of motion. The word "or" leads us to think that the second part means the same thing as the first part.

Had Profesor Rettger examined my book with greater care he would have noticed that I have used the term "reaction" in a slightly different sense and that with this difference the "first part" is not at all Newton's third law but has the same meaning as the "second part," and that the two "parts" are only two different forms of the statics principle. Further he would have seen that the first form is not made use of, the entire work being based upon the second form alone, and would not have charged me of having assumed Newton's third law in addition to the one I have introduced. The first form is left out entirely in the papers which I published on the subject.[1] In one of these papers I have even shown that Newton's third law is a direct consequence of the second form.

I have postulated the following principle, which I have called the *action-principle:*

*The sum of all the actions to which a body or a part of a body is subject at any instant vanishes:*

$$\Sigma A = 0.$$

Then I have classified and defined the different forms of action. On this principle I have based my treatment of mechanics, and claim that I have given it a degree of unity and logical continuity which is not common to treatments of elementary mechanics. This is made possible by the simplicity and flexibility of the action-principle, which is easily grasped by the beginner, yet conveys a depth of meaning and breadth of application commensurate with the knowledge and ability of the student.

Besides this pedagogical advantage my treatment involves a point of view which is in harmony with our present ideas of dynamical phenomena, as it is shown in my recent paper on the subject.[2]

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[1] "On a Progressive Development of the Principles of Mechanics," *Physical Review,* May, 1913; "On a Progressive Development of Mechanics Based Upon a New Form of the Fundamental Principle of the Science," *American Journal of Science,* February, 1914.

[2] *Loc. cit.*

## A NEW METHOD OF COOPERATION AMONG UNIVERSITIES

In April, 1910, was formed at Kansas City, Missouri, the Missouri Valley Conference of Heads and Governing Boards of Universities. The Conference embraced, however, only the institutions up to that time belonging to the Missouri Valley Conference for athletic purposes. There have been many conferences and associations of professors of universities and presidents of universities, or both, and there have been conferences of school boards representing the public schools in various cities, but this is probably the first attempt on the part of university governing boards to accomplish a general understanding and cooperation in regard to matters affecting institutions similarly situated. The conference arose over the matter of intercollegiate football, the question so fruitful of controversy and discussion. The reason for the conference was as follows: There had been introduced into the board of regents of the University of Kansas a resolution abolishing intercollegiate football. The vote was a tie and the motion was lost. The question was brought up again and after thorough discussion it was agreed by the board of regents of the University of Kansas that it was unwise to attempt to settle that question in one university alone and that all of the universities of the then existing Missouri Valley Conference, through their heads and governing boards, should be asked to meet in a general conference at Kansas City in April, 1910. It was at the time of large and pointed discussion and criticism of intercollegiate football and after the matter had been clearly laid before the institutions most interested all of them accepted the invi-